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On the Orbit of 70 *Ophiuchi.* By Eyre B. Powell, Esq.

"Having been for some time engaged in investigating the orbit of the companion to 70 *Ophiuchi*, I have, at length, arrived at an ellipse which represents with considerable accuracy the angular motion of that interesting binary star; and I now do myself the pleasure of communicating my results to the Society.

"The process by which I obtained a first approximate orbit was the graphical one invented by Sir J. Herschel: three corrections then gave me the following elements:—

$$
\begin{aligned}
\tau &= 1806{\cdot}82 \\
\pi &= 291^\circ\, 40' \\
\gamma &= 46 \quad 2 \\
\Omega &= 294 \\
e &= {\cdot}566 \\
n &= -3^\circ{\cdot}676, \text{ and therefore } P = 97{\cdot}93 \text{ years.}
\end{aligned}
$$

"The errors of position afforded by these elements for 1779, 1804, 1825, 1830, 1833, 1842, and 1852, are all moderate, scarcely ever exceeding a degree; but the discrepancy between the observed and computed positions for 1802 reaches the enormous amount of eight degrees. It is worthy of notice that, while the angle for 1802 is so erroneous, the position for 1804 differs by only 8′ from the result of observation.

"The subjoined table contains the variations of the angles of

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position, at eight different epochs, corresponding to changes in the preceding elements:—

Table of Variations of Position.

(Variations in minutes of space.)

Epoch.	τ	ϖ	γ	☊	e	n
1779·77	$+\frac{33a}{4}$	$+\frac{71b}{60}$	$+21k$	$-\frac{67d}{5}$	$+\frac{61f}{2}$	$+\frac{25c}{6}$
1802·34	$+\frac{281a}{4}$	$+\frac{49b}{30}$	$-\frac{73k}{2}$	$-\frac{156d}{5}$	$+125f$	$+\frac{25c}{2}$
1804·42	$+\frac{257a}{4}$	$+\frac{72b}{60}$	$-\frac{7k}{2}$	$-\frac{41d}{5}$	$+69f$	$+\frac{25c}{6}$
1825·56	$+14a$	$+\frac{81\cdot5b}{60}$	$-33k$	$-\frac{79d}{5}$	$-53f$	$-25c$
1830·5	$+9\cdot5a$	$+\frac{71b}{60}$	$-27k$	$-7d$	$-37f$	$-\frac{25c}{2}$
1833·5	$+\frac{33a}{4}$	$+\frac{68b}{60}$	$-\frac{47k}{2}$	$-5d$	$-30f$	$-\frac{25c}{2}$
1842·55	$+\frac{23a}{4}$	$+\frac{62b}{60}$	$-\frac{27k}{2}$	$-\frac{3d}{5}$	$-15f$	$-\frac{25c}{3}$
1852·75	$+5a$	$+b$	$-3k$	$+\frac{2d}{5}$	$-\frac{13f}{4}$	$-\frac{25c}{2}$

a being tenths of a year; b, minutes of space; k, degrees; d, degrees; f, hundredths of unity; and c, minutes of space.

"The inspection of the variations thus drawn together affords hints with regard to the management of the equations of correction for the different elements. Such equations were formed and combined in a variety of ways, so as to make the values of the corrections depend chiefly on those epochal equations in which the corresponding coefficients were largest. The method of least squares is commonly used to attain the greatest accuracy; but it seemed to me that the foregoing plan would be sufficient to answer the purpose in hand. Thus, then, new and more correct values of the elements were found; but, as a comparison of the angles of position afforded by them, with those of observation, was not so satisfactory as I wished, I again altered some of the elements, and finally adopted the following:—

$\tau = 1806\cdot92$
$\varpi = 291^\circ 40'$
$\gamma = 49\ 56$
☊ $= 296\ 30$ and $\lambda = 7^\circ 29'$
$e = \cdot546$
$n = -3^\circ\cdot668$, and therefore $P = 98\cdot146$ years.

"The length of the period is, I believe, considerably greater than any hitherto obtained; but an examination of the angular velocities of the star bears out my result.

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From 1833 to 1853 δ Position = about 19
1842 — 1852 —— = — $8\frac{1}{3}$
1846·2 — 1852·7 —— = — 6

"Now, to complete a whole revolution, so as to reach a position angle of 90°, about $23^\circ\frac{1}{2}$ have to be described; and this will require at least 23 years. Hence, as 74 years have already elapsed, the periodic time cannot differ much from 98 years, and is, probably, somewhat greater.

"I annex a comparison of the observed angles of position with those given by the preceding elements.

Table of Comparisons of Observed and Computed Positions.

Date.	Position Observed.	Position Computed.	Pc—Po.	Observer.
	° ′	° ′	° ′	
1779·77	90 0	89 4	— 56	♅
1802·34	334 38	336 10	+1 32	♅
1804·42	318 40	315 27	—3 13	♅
1821·72	157 39	157 19	— 20	Σ
1822·6	153 54	154 25	+ 31	Σ
1825·56	148 12	146 36	—1 36	Σ & S
1828·67	140 18	140 25	+ 7	Σ & H
1830·5	137 28	137 25	— 3	B, H, & D
1832·561	134 21	134 26	+ 5	H & D
1835·56	130 36	130 37	+ 1	Sm
1838·51	126 30	127 19	+ 49	Sm
1842·55	122 24	123 17	+ 53	Sm
1846·017	120 31	120 7	— 24	J
1850·571	116 6	116 12	+ 6	J & F
1852·75	114 3	114 22	+ 19	J
1854·081	113 39	113 16	— 23	J

♅, Sir W. Herschel; Σ, Professor Struve; S, Sir J. South; H, Sir J. Herschel; B, Professor Bessel; D, the Rev. Mr. Dawes; Sm, Admiral Smyth; J, Captain Jacob; F, Mr. Fletcher.

"The epochs pitched upon for the comparison were generally those for which there existed the most trustworthy observations; and in making the selection, I was guided, not only by the circumstances recorded of the measures, but by the angular velocities the latter afforded. Also, in combining the values assigned by different observers, I took the liberty of allotting weights according to the coherence and number of the sets of measures. The position for 1850 is a simple arithmetical mean between the angles of Captain Jacob and Mr. Fletcher, which differ *inter se* by nearly two degrees. I am inclined to think that Captain Jacob's angle for 1854 is rather too high; first, as the angular velocity obtained by combining it with his measure for 1852 is only three-tenths of a degree; and secondly, as I made the position for

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1853·586, by 59 fairly accordant observations, equal to 113° 35′, which is but 5′ less than the result of calculation.

“ Using the elements and the measured distances for 1781, 1825, 1828, 1830, 1832, 1835, 1838, 1842, and 1850, I computed the corresponding values of a, the semi-axis major; the mean came out 4″·48.

“ With this value of a the following table was formed, showing the comparison of the calculated and observed distances for thirteen epochs. The inclination of the true distance to the apparent one is included in the table, as it may be satisfactory to see its effect in fore-shortening the radius vector. The formulæ used were

$$\sin \mathrm{I} = \sin \gamma \sin (v \pm \lambda), \quad \varrho = a\,(1 - e \cos u), \quad \text{and} \quad r = \varrho \cos \mathrm{I}.$$

Table of Comparison of Observed and Computed Distances.

Date.	ϱ, or Radius Vector.	I, or Inclination. ° ′	r_c, or Comp. Dist.	r_o, or Observ. Dist.	$r_c - r_o$.	Observer.
1781·74	5·687	31 9	4·867	4·49	+·377	♅
1804·42	2·177	21 6	2·031	2·56	—·529	♅
1825·56	4·873	30 48	4·186	4·00	+·186	Σ
1828·67	5·288	25 44	4·764	4·79	—·026	Σ
1830·5	5·509	23 0	5·071	5·478	—·407	B, Sm, & D
1832·561	5·736	20 6	5·386	5·456	—·070	H & D
1835·56	6·028	16 10	5·79	5·97	—·180	Sm
1838·51	6·273	12 35	6·123	6·351	—·228	B, Sm, & D
1842·55	6·543	7 59	6·48	6·682	—·202	Sm & D
1846·017	6·716	4 18	6·697	6·83	—·133	J
1850·571	6·864	0 30	6·864	6·86	+·004	J
1852·75	6·904	2 31	6·897	6·73	+·167	J
1854·081	6·918	3 50	6·903	6·365	+·538	J

“ On glancing at the numbers in the sixth column, the arrangement of the signs of $r_c - r_o$ suggests the existence of error in the elements. It has been asserted that the distance is now decreasing; if this be correct, the node, or the peri-astre, or both, should be somewhat advanced. As, however, the measures of distance are undoubtedly less worthy of confidence than those of position, it appears unnecessary at present to modify the elements with the sole view of reconciling the distances. No weight can be attached to the distance of 1804, as it was obtained by mere estimation in diameters. In 1825 Professor Struve found the projected radius vector 4″·0, Sir J. South 4″·76; the true value in all probability lies between these determinations, and, perhaps, nearer the former than the latter. This opinion is grounded upon two facts; first, that on Professor Struve's testing his distances, he found them on an average about two-tenths of a second too small; and secondly, that the distance in 1828 was only 4″·79, while

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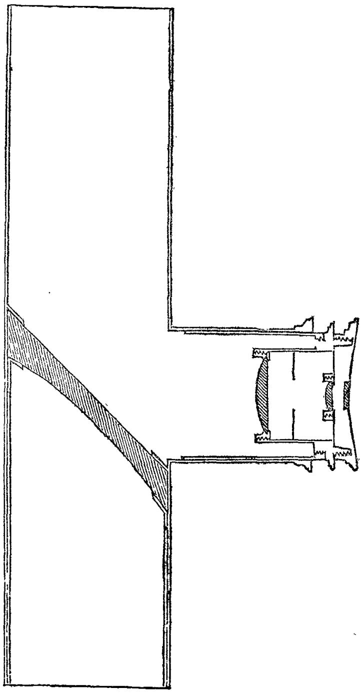
from the nature of the orbit the value of r was increasing pretty rapidly. For 1850 Captain Jacob and Mr. Fletcher differ by $0''\cdot366$, and the distance by computation agrees nearly with that obtained by the former. The most offensive discrepancy in the table is that for the current year; but even here it seems probable the orbit is not so far in fault as might at first be fancied. The angular velocity is apparently as small, or even smaller, than it was prior to 1850, and the radius vector lies near both the axis major and the line of nodes; hence there can be but a slight change in the distance.

"Upon the whole, the preceding elements appear to represent the motion of 70 *Ophiuchi* tolerably well; and it is to be feared that, till the companion approaches its peri-astre, but little can be done to fix definitively the most important points connected with the orbit. Probably, however, three or four years' farther observations will put it in our power to improve the position of the ellipse with reference to the line of nodes.

"*Madras, August 9th,* 1854."

Description of an Eye-piece for Observing the Sun.

By R. Hodgson, Esq.



"The novelty in the arrangement of this eye-piece is, that it permits the full aperture of the object-glass to be used while observing the whole of the sun's disk; an object of importance in solar eclipses and transits of planets across the sun; and it has also the further advantage of allowing the application of all the usual eye-pieces and micrometers.

"It consists in applying to the draw-tube of the telescope a diagonal glass reflector, about two inches in advance of the focal point; the first or reflecting surface being perfectly flat, and the second ground to a concave figure, and left unpolished: a dark glass is, of course, still necessary to protect the eye from the glare of the sun; but a light neutral tint is sufficient.

"I have applied it to my 6-inch equatoreal, and also tried it with equal success upon a telescope of 8 inches' aperture.

"*November* 1854."